REMARKS

In the present application, claims 1-12, 15, 16, 20-36 and 69-77 are pending. Claims 6, 10, 15, 16, 20, 21, 22, 23, 24, 26, 34, 69 and 74 have been amended. Additionally, new claims 78-92 have been added.

35 U.S.C. §112

Claim 34 was rejected under 35 U.S.C. §112, first paragraph. The Examiner asserts that he can find no support for the claimed limitation of a drain region doped with boron. Claim 34 has been amended herein to recite that the drain comprises a dopant implanted into an active area. Basis for this amendment can be found for example, from page 15 line 30 - page 16, line 2 and Figure 3C.

35 U.S.C. §102

Claims 10-12, 26-28, 35 and 36 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,386,132 (hereinafter "Wong"). According to the M.P.E.P. §706.02, in order to be anticipating under §102, the reference must teach every aspect of the claimed invention. *Carella v. Starlight Archery and Pro Line Co.*, 804 F.2d 135, 138, 231 U.S.P.Q. 644, 646 (Fed. Cir. 1986).

Claims Amended to Include Limitations Already Deemed Allowable

The Examiner has provided early indication of the allowable subject matter of claims 1-9, 15, 16 and 20-25. In the Office Action, the Examiner indicates that the above claims are allowable because the Examiner is unaware of any prior art that teaches or suggests a memory device with two transistors, which has a vertical channel, (with the drain over the source), a floating gate over the drain, a select gate within a trench, and a feature size of less than $4F^2$.

Of the above rejected claims, only claims 10 and 26 are in independent form. Both claim 10 and 26 have been amended herein to include all of the above-described features that the Examiner has already indicated constitutes allowable subject matter.

As such, the applicant believes that the above-rejected claims are allowable over the art of record.

Prior Art Reference Fails to Teach or Suggest All Limitations

Wong fails to establish a *prima facie* case of anticipation over the above claims as amended herein. For example, claims 10 and 26 have been amended herein to recite a memory cell that defines a square feature size of less than $4F^2$. Support for these amendments may be found for example, on page 11, lines 1-12 of the present specification.

As best seen in Fig. 13 of Wong, the smallest realizable square feature size of the memory device is defined by a wordline pitch of 2F (seen vertically on the figure) and a bitline pitch of 2F (seen horizontally on the page), thus the memory cell has a minimum realizable square feature size of $4F^2$. This is also pointed out in the specification of Wong on column 12, lines 51-60. Note further, that each cell in Wong is defined at the intersection of a wordline and bitline, see Col. 11, lines 54-56. As such, the size of each cell in Wong is by *definition*, the wordline pitch by the bitline pitch and thus *cannot* be formed in a square feature space less than $4F^2$.

In contrast, the present claimed invention is fabricated to have a minimum realizable square feature size of less than $4F^2$. An example can be seen from an examination of Fig. 1 of the present application. This example is intended to be merely illustrative and not limiting to the scope of the claimed invention. As shown, a memory cell according to the present claimed invention can has a feature size of 1F in a first dimension, which is half of the digit line pitch, and a feature size of 2F in a second dimension, which is the word line pitch. See the specification as amended herein on page 11, lines 8-15. Clearly, when inspecting Fig. 1 (also seen in Figs. 2A, and 2B), one sees unit repeating cells in both the X and Y directions. Each unit is comprised of a 2-feature width -1 bitline feature (bitline stack 210 seen in Fig. 2A) and a bitline space feature (trench 205 and gates 206). The unit also has a feature size of 2F in an

orthogonal direction as seen in Fig. 2B defined by 1 wordline feature, and 1 wordline space feature.

Thus the unit has a feature size of $4F^2$. However, note that *two* memory cells are formed per unit. That is, each bitline 210 is shared between two cells with one cell on opposite sides thereof. Further, each bitline space feature defines the select gate, which is shared between two cells, one on each side thereof. As such, the realized feature size of each memory cell is only $2F^2$. Moreover, the fact that the memory cell is confined to a $2F^2$ space structurally limits the layout of the memory cell. For example, because the memory cell of Fig. 2 has a feature size of 2F in one dimension (the wordline plus wordline space), the memory cell must necessarily include the bitline contact and gate in the space of one feature.

It is clear that Wong does not teach or suggest a $2F^2$ device. It should further be observed that the inherent design of the memory cell in Wong lends itself to a relatively large square feature size compared to the present invention. For example, note also that the N+ region of the drain in Wong is highly resistive, which places a further practical limit on the utility of the memory cell taught thereby. No strapping layers or other interfaces are provided to connect the plugs to the N+ regions. This may adversely affect the possible reduction of size of the memory cell taught by Wong.

Accordingly, the applicant requests that the Examiner withdraw the rejection of claim 10 and the claims that depend therefrom, including claims 11 and 12, under 35 U.S.C. §102(b). Further, the applicant requests that the Examiner withdraw the rejection of claim 26 and the claims that depend therefrom, including claims 27, 28, 35 and 35 under 35 U.S.C. §102(b).

Claims 69-77 were rejected under 35 U.S.C. §102(b) as being anticipated by Wong. Wong fails to establish a *prima facie* case of anticipation over the above claims as amended herein. For example, of the above-rejected claims, only claims 69 and 74

are in independent form. Claims 69 and 74 have been amended herein to recite that the floating gate is both horizontal and sub lithographic, and the square feature size of the memory device is not greater than $2F^2$. Support for these amendments may be found for example, on page 11, lines 1-12 and page 12 lines 10-12 of the present specification.

Both claim 69 and 74 have been amended herein to include all of the above-described features that the Examiner has already indicated constitutes allowable subject matter. As such, the applicant believes that the above-rejected claims are allowable over the art of record.

Also, as pointed out in greater detail above, Wong does not teach a memory device having a minimum realizable square feature size of less than $4F^2$, thus Wong does not teach or suggest a $2F^2$ device. Further, as amended herein, both claims 69 and 74 recite that the floating gate is horizontal and formed adjacent to the trench. However, as shown in Figure 6 of Wong, the floating gate 605 is formed vertically and *within* the trench.

Accordingly, the applicant requests that the Examiner withdraw the rejection of claim 69 and the claims that depend therefrom, including claims 70-73, under 35 U.S.C. §102(b). Further, the applicant requests that the Examiner withdraw the rejection of claim 74 and the claims that depend therefrom, including claims 75-77 under 35 U.S.C. §102(b).

Claims 74-77 are further rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Pat. No. 5,576,567 (hereinafter ""Mori").

Mori fails to establish a *prima facie* case of anticipation over the above claims as amended herein. For example, of the above-rejected claims, only claim 74 is in independent form. Claim 74 has been amended herein to recite that the floating gate is

horizontal and is formed over the second layer adjacent to the trench so as to avoid extending vertically down into trench below the second layer, wherein the floating gate is dimensioned so as to define a sublithographic gate. Moreover, claim 74 has been amended herein to recite that the memory device defines a square feature size of not greater than $2F^2$. Support for these amendments may be found for example, on page 11, lines 1-12 and page 12, lines 5-15 of the present specification.

As pointed out above, Claim 74 has been amended herein to include all of the above-described features that the Examiner has already indicated constitutes allowable subject matter. As such, the applicant believes that the above-rejected claims are allowable over the art of record.

It should be observed however, that the floating gate taught in Mori, as best seen in Fig. 1a, is formed in a conventional manner by positioning the floating gate FG *vertically* in the trench 22 adjacent to the select gate (program gate PG). As can be seen in Fig. 1a of Mori, the floating gate is formed so as to essentially line the trench walls. The floating gate extends down below the N+ buried source on opposite sides of the program gate PG. Also, the cell formed by the invention in Mori results in a minimum realizable square feature size of $6F^2$, see for example, Col. 4, lines 36-38; Col. 4 lines 48-60.

Accordingly, the applicant requests that the Examiner withdraw the rejection of claim 74 and the claims that depend therefrom, including claims 70-73, under 35 U.S.C. §102(b).

ALLOWABLE SUBJECT MATTER

The applicant would like to thank the Examiner for the early indication of the allowable subject matter of claims 1-9, 15, 16 and 20-25.

In response to the objection of claims 29-33, the applicant has not rewritten these claims in independent form because the applicant believes that claim 26, from which the above-objected to claims depend, is not patentable over the art of record as amended herein and as described in greater detail above.

New Claims:

The applicant believes that the newly added claims 78-99 are patentable over the art of record. Particularly, all of the newly added claims are in dependent form. Briefly, claims 78-85 further limit the base claim from which the respective new claim depends to recite a memory cell or device having a square feature size of $2F^2$. Support for the new claims can be found for example, on page 11, lines 1-12.

New claims 86-92 further limit the base claim from which the respective new claim depends by reciting that the select gate is the only vertical gate formed in the trench. Support is for these new claims is seen most readily for example, in Figures 2A and 8A of the present invention. It should be observed that these new claims further distinguish over Wong. In each embodiment of Wong, there are two gates formed in the trench. The select gate and the floating gate. The only horizontal gate taught by Wong is the *addition* of a third gate, the erase/program gate. See Figs. 6-9; 10C-10E; 12D, and 14C-15 and supporting text in the specification of Wong.

Placing the floating gate in the sidewall of the trench as is done in Wong results in the floating gate being aligned to a <1 1 1> plane or other crystallographic structures that have a higher density of bonds. Such a placement typically results in an inferior oxide resulting in retention, cycling and trapping problems within the memory cell. However, the present claimed invention provides a substantially horizontal floating gate and is arranged in the <1 0 0> plane thereby avoiding the above-mentioned problems. See the present specification as amended herein starting on page 17, lines 18-25.

STATEMENT REGARDING REASONS FOR ALLOWANCE

The applicant has fully complied with 37 CFR 1.111 (b) and (c) and 37 CFR 1.133(b) and thus believe that the prosecution *as a whole* makes clear the reasons for allowance thus satisfying 37 CFR 1.104(e). As such, the comments by the Examiner in the Reasons for Allowance, should not be construed to place unwarranted interpretations, whether broad or narrow, upon the allowed claims and should not give rise to any negative implications therefrom.

CONCLUSION

The applicant respectfully submits that the pending claims represent allowable subject matter. The Examiner is encouraged to contact the undersigned to resolve efficiently any formal matters or to discuss any aspects of the application or of this response. Otherwise, early notification of allowable subject matter is respectfully solicited.

Respectfully submitted,

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